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# ENVIRONMENTAL LEVELS OF RADIOACTIVITY FOR THE OAK RIDGE AREA

(Report for Period, July - December, 1963)

Compiled by the

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OAK RIDGE NATIONAL LABORATORY

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## Introduction

Radioactive waste materials arising from the operation of atomic energy installations at Oak Ridge are collected, treated, and disposed of according to their physical states.

Solid wastes are buried in a Conasauga shale formation. This shale has a marked ability to fix radioactive materials by an ion exchange mechanism.

Liquid wastes which contain long-lived fission products are confined in storage tanks or are released to trenches located in the Conasauga shale formation. (The use of pits for disposal of liquid waste was discontinued as of November, 1962.) Low level liquid wastes are discharged, after preliminary treatment, to the surface streams.

Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of filters, scrubbers, and/or precipitators.

This report presents data on the environmental levels of radioactivity for the Oak Ridge Area and compares the data with established maximum permissible concentrations.

## Air Monitoring

Atmospheric contamination by long-lived fission products and by fallout occurring in the general environment of East Tennessee is monitored by two systems of monitoring stations. One system consists of seven stations which encircle the plant areas (Fig. 1) and provide data for evaluating the impact of all Oak Ridge Operations on the immediate environment. A second system consists of seven stations encircling the Oak Ridge Area at distances of from 12 to 75 miles (Fig. 2). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur. Sampling is carried out by passing air continuously through a filter paper. Data collected are accumulated and tabulated in average  $\mu\text{c/cc}$  of air sampled.

Atmospheric contamination by alpha-emitting materials, interpreted as uranium, is determined by taking continuous air samples at three locations on a five-mile radius from the Oak Ridge Gaseous Diffusion Plant (Fig. 3).

## Water Monitoring

Large volume, low level liquid wastes originating at Oak Ridge National Laboratory are discharged, after some preliminary treatment, into the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the Oak Ridge Gaseous Diffusion Plant

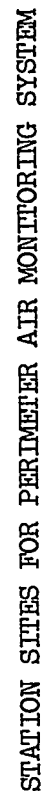


Figure 1

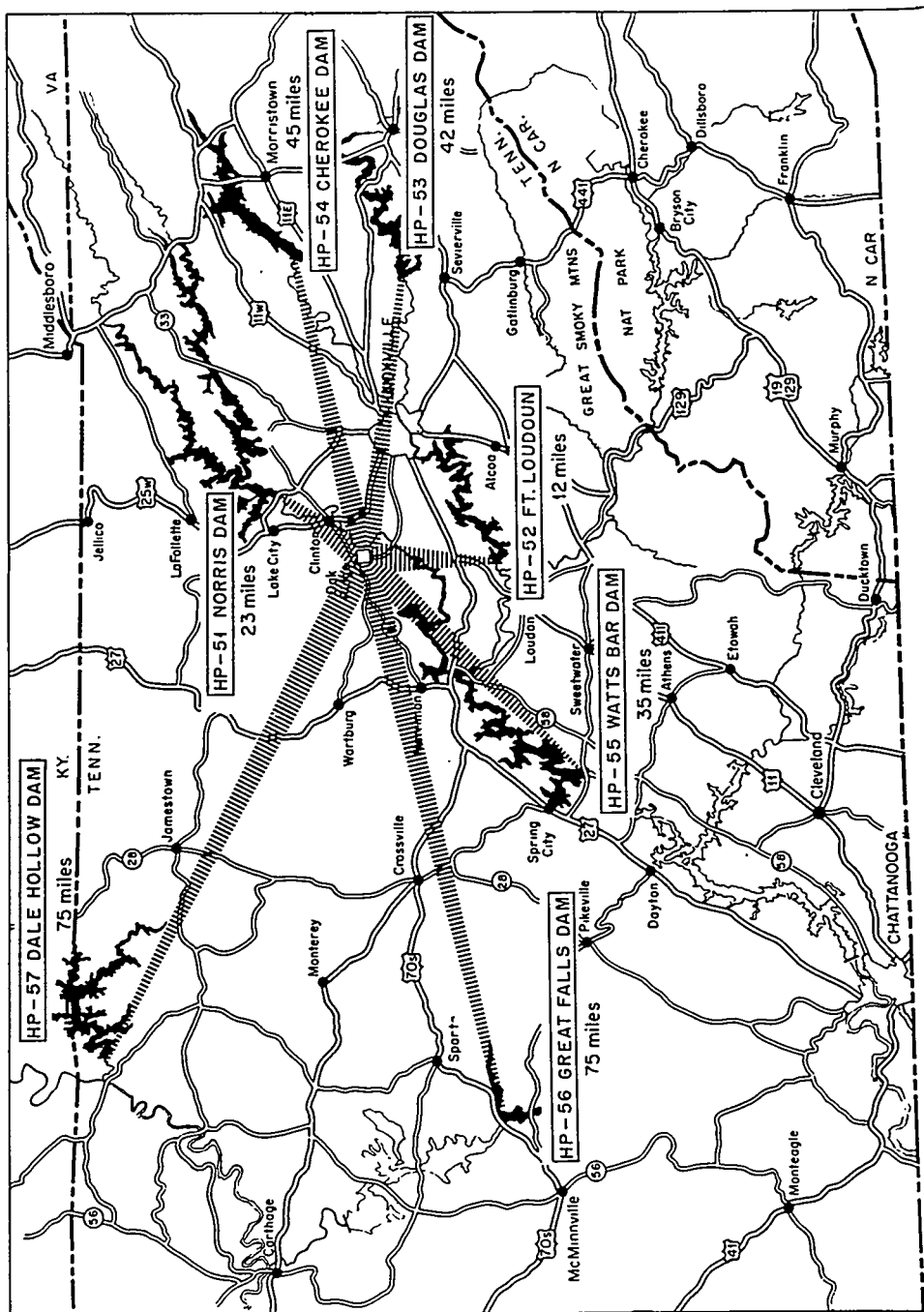
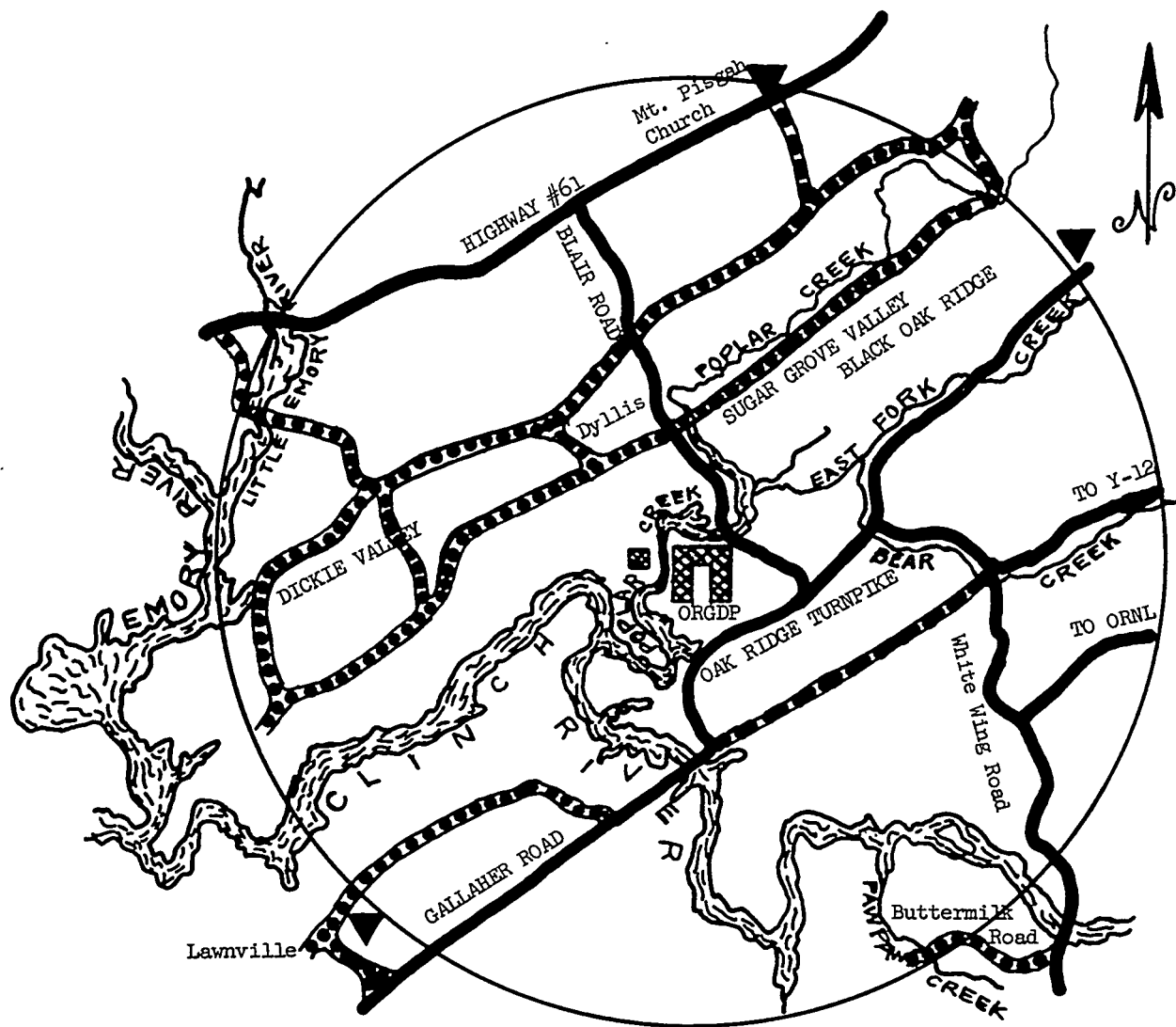


Figure 2



SAMPLING POINTS OF OUTSIDE ENVIRONS -- ORGDP

AIR



Sampling Location - Five Miles from Plant

Figure 3

and the Y-12 Plant are discharged to Poplar Creek and thence to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with the maximum permissible levels for populations in the neighborhood of a controlled area as specified by AEC Manual, Chapter 0524. The concentration of radioactivity leaving White Oak Creek is measured and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.

Radioactive liquid wastes are sampled at a number of locations as shown in Figs. 4 and 5. Samples are taken at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tennessee. Stream gauging operations are carried on continuously by the United States Geological Survey to obtain dilution factors for calculating the probable concentrations of wastes in the river.

Samples are analyzed for the long-lived beta emitters, for uranium, and for the transuranic alpha emitters.

Analyses are made of the effluent for the long-lived radionuclides only since cooling time and hold-up time in the waste effluent system is such that short-lived radionuclides are not present. The concentrations of those isotopes present in significant amounts are determined by analysis. A weighted average maximum permissible concentration for water,  $(MPC)_w$ , for the mixture of radionuclides is calculated on the basis of the isotopic distribution using the MPC values of each isotope as specified by AEC Manual, Chapter 0524.<sup>1</sup> The average concentrations of gross beta activity in the Clinch River are compared to the calculated  $(MPC)_w$  values.

The concentration of uranium is compared with the specific  $(MPC)_w$  value for uranium.

#### Gamma Measurements

External gamma radiation levels are measured monthly at a number of locations in the Oak Ridge Area. Measurements are taken with a Geiger-Müller tube at a distance of three feet above the ground, and the results are tabulated in terms of mR/hr.

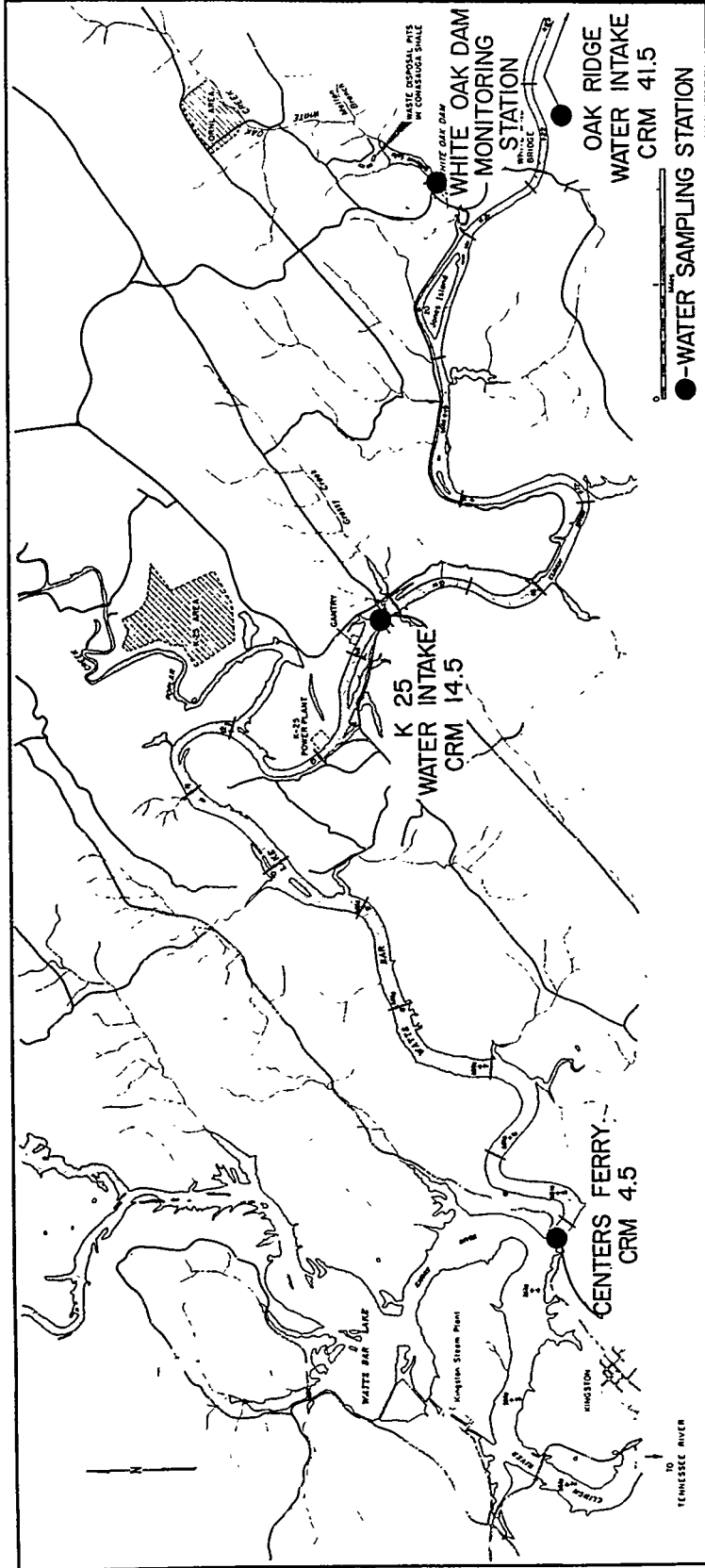
#### Discussion of Data

Data on the environmental levels of radioactivity for the second half of 1963 in the Oak Ridge and surrounding areas are presented in Table I through Table VI.

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<sup>1</sup>AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

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WATER SAMPLING LOCATIONS

Figure 4

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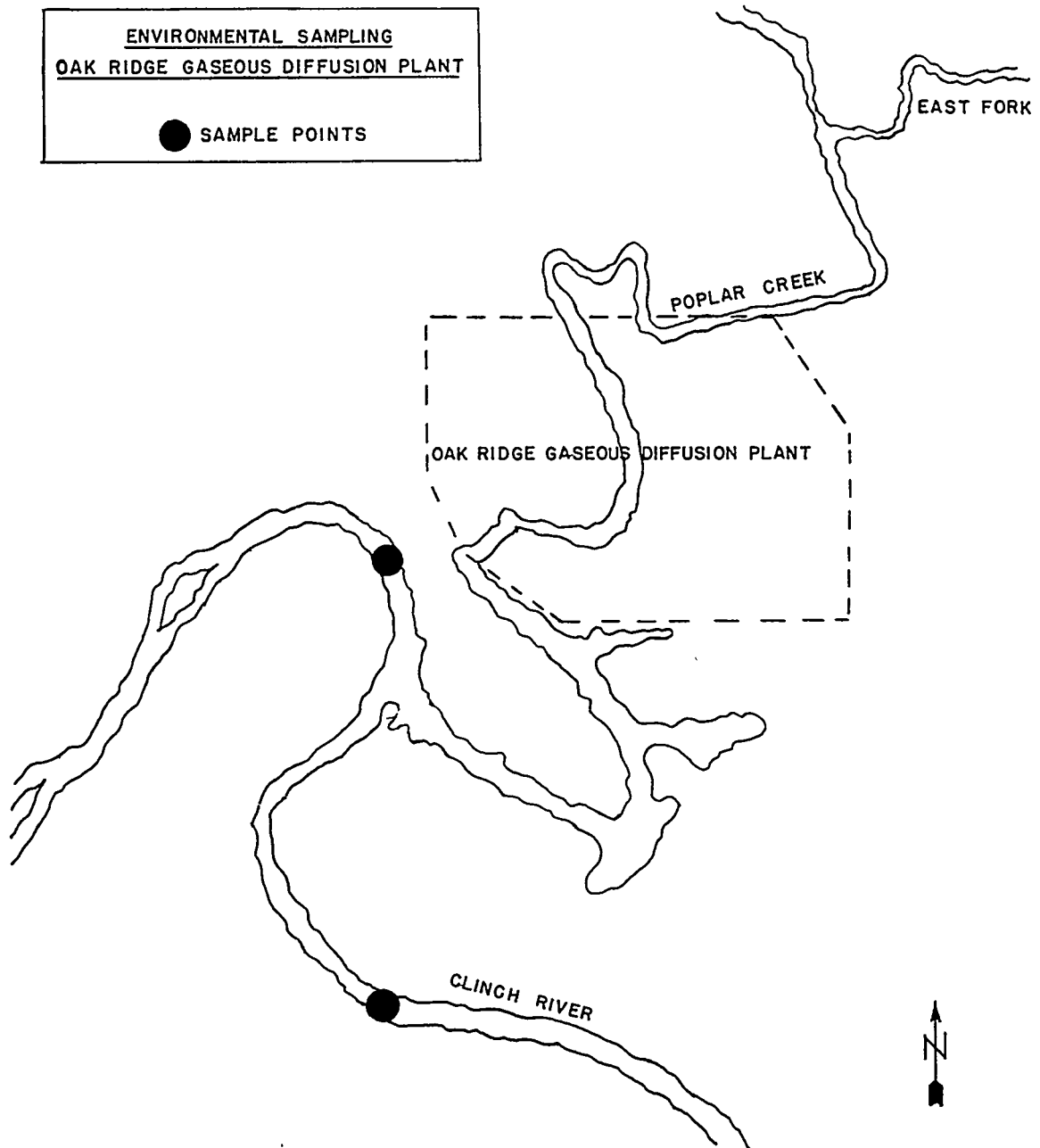


Figure 5



The average air contamination levels for gross beta activity, as shown by the continuous air monitoring filter data for the immediate and remote environs of the plants, were 2.0% and 2.4% respectively, of the maximum permissible concentration for populations in the neighborhood of a controlled area. These values are approximately a factor of three lower than those of the first half of 1963 but are not significantly different from the average of those measured in other areas of the United States and reported by the U. S. Public Health Service Radiation Surveillance Network for the period July through November, 1963.

The average air-borne alpha activity in the environs of the ORGDP, five miles from ORGDP, was 20% of the maximum permissible concentration for populations in the neighborhood of a controlled area.

The average concentrations of radioactivity in the Clinch River at Mile 20.8, the point of entry of most of the wastes, and at Mile 4.5, near Kingston, Tennessee, were  $8.6 \times 10^{-8}$   $\mu\text{c/ml}$  and  $4.4 \times 10^{-8}$   $\mu\text{c/ml}$  respectively. These values are 3.3% and 4.0% of the weighted average maximum permissible concentration  $(\text{MPC})_w$ . The average concentration of transuranic alpha emitters in the Clinch River at Mile 20.8 was  $5.9 \times 10^{-11}$   $\mu\text{c/ml}$  which is approximately 0.002% of the weighted average  $(\text{MPC})_w$  value.

The average activity of natural uranium materials in the Clinch River, reflecting the effects of all Oak Ridge Plants, was 0.01% of the  $(\text{MPC})_w$  for uranium.

Fall-out from weapons tests continues to result in increased concentrations of  $\text{Sr}^{90}$  and  $\text{Ce}^{144}$  in Clinch River water, Table IV, CRM 41.5, upstream from the point of entry of the wastes into the river.

External gamma radiation in the Oak Ridge Area averaged 0.023 mR/hr.

### Conclusion

The air and ground contamination found in both the immediate and remote environs of Oak Ridge is due primarily to fall-out from sources other than local plant operations. From analysis of the data presented, it may be concluded that the Oak Ridge Operations contributed little to air or ground contamination in the neighborhood of the area controlled by the Atomic Energy Commission.

While some radioactivity is being contributed to the Clinch River by the release of low level radioactive liquid wastes from local operations, the resulting concentrations in the river are well below the maximum permissible concentration for populations residing in the neighborhood of a controlled area.

TABLE I

## CONTINUOUS AIR MONITORING DATA

Long-Lived Gross Beta Activity of  
Particulates in AirJuly - December, 1963

Station Number	Location	Number of Samples Taken	Units of 10-13 $\mu\text{c/cc}$			% of (MPC) <sub>a</sub> <sup>c</sup>
			Maximum <sup>a</sup>	Minimum <sup>b</sup>	Average	
<u>Perimeter Stations</u>						
HP-31	Kerr Hollow Gate	26	68	5	22	2.2
HP-32	Midway Gate	26	69	5	23	2.3
HP-33	Gallaher Gate	26	49	3	16	1.6
HP-34	White Oak Dam	26	57	3	18	1.8
HP-35	Blair Gate	26	69	4	22	2.2
HP-36	Turnpike Gate	180 <sup>d</sup>	66	4	22	2.2
HP-37	Hickory Creek Bend	26	61	4	20	2.0
Average					20	2.0
<u>Remote Stations</u>						
HP-51	Norris Dam	26	59	5	23	2.3
HP-52	Loudoun Dam	25	91	4	27	2.7
HP-53	Douglas Dam	25	78	4	24	2.4
HP-54	Cherokee Dam	26	74	6	27	2.7
HP-55	Watts Bar Dam	26	72	5	23	2.3
HP-56	Great Falls Dam	26	75	5	24	2.4
HP-57	Dale Hollow Dam	26	56	5	22	2.2
Average					24	2.4

<sup>a</sup>Maximum weekly average concentration.<sup>b</sup>Minimum weekly average concentration.<sup>c</sup>(MPC)<sub>a</sub> is taken to be  $10^{-10}$   $\mu\text{c/cc}$  as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.<sup>d</sup>Samples collected on daily schedule beginning 5/7/62. Maximum and minimum daily average concentrations were  $90 \times 10^{-13}$   $\mu\text{c/cc}$  and  $3.0 \times 10^{-13}$   $\mu\text{c/cc}$  respectively.

TABLE II  
OAK RIDGE GASEOUS DIFFUSION PLANT AIR MONITORING DATA

July - December, 1963

Distance from Center of Plant	Type of Analyses	No. of Samples*	Units of 10-13 $\mu\text{c/cc}$			
			Direction from Plant		Average	(MPC) <sub>a</sub>
			North	North East		
5 Mile Radius	Gross Alpha	1418	2.5	5.0	2.5	20

\* Normal Sampling Frequency: Continuous, averaged over 8 hours.

TABLE III  
CALCULATED AVERAGE CONCENTRATION OF RADIOACTIVITY  
IN THE CLINCH RIVER AT MILE 20.8

July - December, 1963

Number of Samples Taken	Units of $10^{-7} \mu\text{c/cc}$			% of $(\text{MPC})_w$
	Maximum <sup>a</sup>	Minimum <sup>b</sup>	Average	
182	4.6	0.08	0.86	3.3

<sup>a</sup>Maximum weekly average.

<sup>b</sup>Minimum weekly average.

TABLE IV  
AVERAGE CONCENTRATION OF MAJOR RADIOACTIVE CONSTITUENTS  
IN THE CLINCH RIVER

July - December, 1963

Location	Units of $10^{-8}$ $\mu\text{c/ml}$							% of	
	$\text{Sr}^{90}$	$\text{Ce}^{144}$	$\text{Cs}^{137}$	$\text{Ru}^{103-106}$	$\text{Co}^{60}$	$\text{Zr}^{95}$ - $\text{Nb}^{95}$	Average Beta Activity	$(\text{MPC})_w^a$	$(\text{MPC})_w$
Mi. 41.5 <sup>b</sup>	0.15	0.13	0.04	0.50	0.02	0.05	0.89	56	1.6
Mi. 20.8 <sup>c</sup>	0.14	0.01	0.13	2.8	0.21	0.04	8.6	260	3.3
Mi. 4.5	0.36	0.16	0.16	3.4	0.23	0.07	4.4	110	4.0

<sup>a</sup>Weighted average  $(\text{MPC})_w$  calculated for the mixture using  $(\text{MPC})_w$  values for specific radionuclides specified by AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

<sup>b</sup>Sampling station moved from Clinch River Mile 33.2 to Mile 41.5 about January 1, 1962.

<sup>c</sup>Values given for this location are calculated values based on levels of waste released and the dilution afforded by the river; they do not include amounts of radioactive material (e.g., fall-out) that may enter the river upstream from CRM 20.8.

TABLE V  
URANIUM CONCENTRATION IN THE CLINCH RIVER

July - December, 1963

Sampling Point	Type of Analyses Made	No. of Samples*	Units of $10^{-8}$ $\mu\text{c/cc}$				$\% \text{ (MPC)}_w$
			Maximum	Minimum	Average	$(\text{MPC})_w$	
Upstream from ORGDP	Uranium Concentration	24	5.6	0	0.8	2000	0.04
Downstream from ORGDP	Uranium Concentration	24	1.5	0	0.2	2000	0.01

\*Normal Sampling Frequency: Continuous, composited over one week.

TABLE VI  
EXTERNAL GAMMA RADIATION LEVELS

mR/hr

July - December, 1963

Station Number	Location	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1	Solway Gate	0.038	0.040	0.017	0.023	0.024	0.017	0.026
2	Y-12 East Portal	0.025	0.036	0.023	0.022	0.018	0.014	0.023
3	Newcomb Road, Oak Ridge	0.036	0.034	0.015	0.018	0.014	0.014	0.022
4	Gallaher Gate	0.042	0.043	0.020	0.023	0.019	0.018	0.028
5	White Wing Gate	0.017	0.022	0.014	0.014	0.013	0.012	0.015
Average		0.031	0.035	0.018	0.020	0.018	0.015	0.023

Note: These readings were taken with a calibrated Geiger-Muller tube at a distance of three feet above the ground.

The background in the Oak Ridge area in 1943 was determined to be approximately 0.012 mR/hr.